



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Direct Geometric Texture Synthesis and Transfer on 3D Meshes

Citation for published version:

Breckon, TP & Fisher, R 2006, Direct Geometric Texture Synthesis and Transfer on 3D Meshes. in *Visual Media Production, 2006. CVMP 2006. 3rd European Conference on*. Institute of Electrical and Electronics Engineers (IEEE), pp. 186-186. <http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4156038>

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Early version, also known as pre-print

Published In:

Visual Media Production, 2006. CVMP 2006. 3rd European Conference on

General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.



Direct Geometric Texture Synthesis and Transfer on 3D Meshes

Toby. P. Breckon¹, Robert. B. Fisher²

¹ School of Engineering, Cranfield University, UK. toby.breckon@cranfield.ac.uk

² School of Informatics, University of Edinburgh, UK. rbf@inf.ed.ac.uk

Keywords: geometric texturing, 3D surface texture.

Abstract

We present a technique for the transfer and synthesis of geometric texture on 3D surface meshes. Our technique combines localised surface fitting together with non-parametric sampling to facilitate the extraction, transfer and successful synthesis of geometric relief from one surface mesh to another.

1 Introduction

Geometric texturing uses localised 3D vertex displacements to represent surface texture in place of conventional 2D intensity based texture mapping. This allows the surface texture to be realistically re-lit from directional light sources and offers tactile interaction using haptic devices. Here we investigate “*geometric texturing by example*” - the transfer and synthesis of geometric texture from real surface meshes (*sample*), captured via 3D laser scanner, onto synthetically created surface meshes (*target*).

Prior work in this area is limited to solutions that utilise restrictive surface representations (voxels [1], geometry images [5]) rather than conventional meshes. By contrast we propose an approach that operates directly upon surface meshes using a two stage texture extraction and transfer/synthesis process.

2 Texture Extraction

We extract the geometric texture (localised surface relief) from the original surface mesh using localised surface fitting [4] to recover an orthogonal 3D displacement map for the sample surface.

Prior to extraction the sample and target surfaces are *vertex density correlated* to avoid the potential effects *geometric aliasing* on the later transfer/synthesis process [2]. This is performed by oversampling the lesser density of the pair (to an approximate equilibrium) via planar tessellation to avoid interfering with the Nyquist properties of the texture itself [2].

3 Texture Synthesis

Our geometric texture synthesis is based on an adaption of a non-parametric sampling approach [3] to 3D surface meshes. Initially, we copy a small seed patch of texture from our sample displacement map to the target surface. From this we grow the texture outwards, vertex-by-vertex, by iteratively propagating vertex displacement, from the sample, that is locally consistent with the textured vertex neighbourhood, $N(t)$, surrounding the current target vertex, t .

Local consistency is based on the rigid transformation and projection of the local vertex neighbourhood from the target surface, $N(t)'$, to every location, s , on the sample surface. A matching score for each is computed based to the weighed sum of squared projection distances (SSD) at each location [2]:

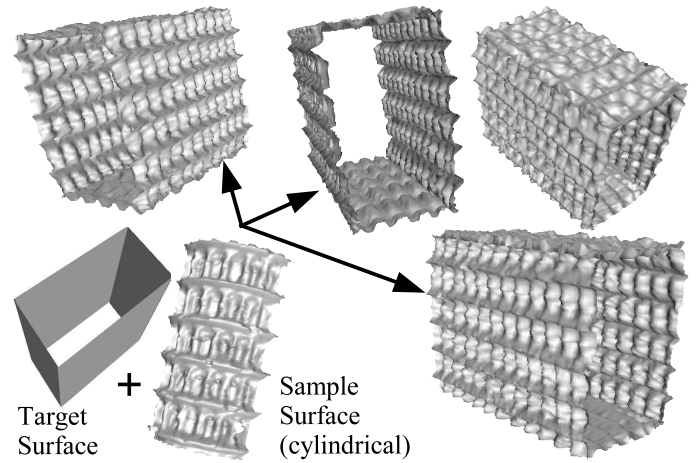


Figure 1: Transfer/synthesis of regular geometric texture

$$SSD = \sum_s \sum_{v \in N(t)'} w_v \min_{\Delta \in \text{triangles}(s)} (\text{dist}(v, \Delta)^2) \quad (1)$$

Texture diversity is maintained by stochastic selection from the top $\eta\%$ of matches found. “*Localness*”, the size of $N(t)$, is user defined by relation to the perceptual scale of texture features and rigid transformation is based on prior knowledge of a consistent orientation field for each surface - either user specified or constructed via an iterative convergence approach.

4 Results

To suitably illustrate the success of the approach, Figures 1 and 2 show the direct transfer of both regular architectural (1) and irregular natural (2) textures between differing surface meshes. The success of our approach is evident from both.

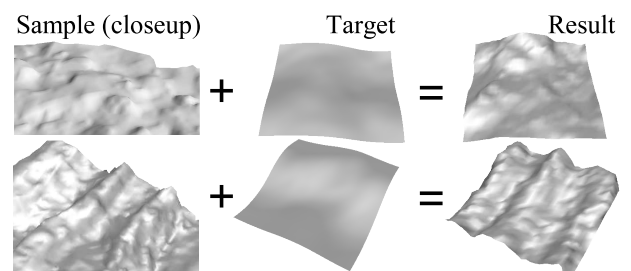


Figure 2: Texture transfer of regular/irregular texture

Future work: intelligent seeding, hierarchical surface meshes.

- [1] P. Bhat, S. Ingram, and G. Turk. Geometric texture synthesis by example. In *Proc. SIGGRAPH : Geom. Proc.*, pages 41–44, 2004.
- [2] T.P. Breckon and R.B. Fisher. Non-parametric 3D surface completion. In *Proc. 3DIM*, pages 573–580, 2005.
- [3] A.A. Efros and T.K. Leung. Texture synthesis by non-parametric sampling. In *Proc. IEEE ICCV*, pages 1033–1038, 1999.
- [4] P. Faber and R.B. Fisher. Euclidean fitting revisited. In *Proc. 4th Int. Work. on Visual Form*, pages 165–175, 2001.
- [5] Y.K. Lai, S.M. Hu, D.X. Gu, and R.R. Martin. Geometric texture synthesis and transfer via geometry images. *ACM SPM*, pages 15–26, 2005.